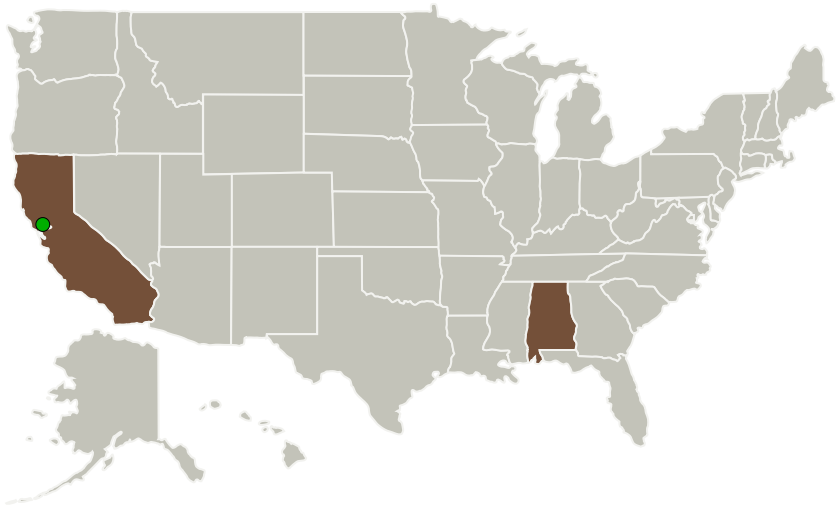
Computational Tool for Coupled Simulation of Nonequilibrium Hypersonic Flows with Ablation, Phase II

Completed Technology Project (2011 - 2013)

Project Introduction

The goal of this SBIR project is to develop a predictive computational tool for the aerothermal environment around ablation-cooled hypersonic atmospheric entry vehicles. This tool is based on coupling the relevant physics models to the LeMANS code for hypersonic flows and to the MOPAR code for material response, both developed by the University of Michigan. In Phase I of this project, we developed an efficient, high-fidelity 3-D radiation transfer equation (RTE) solver based on the Modified Differential Approximation (MDA). The MDA method was shown to be accurate over at least three orders of magnitude variation in medium optical thickness, typical in entry hypersonic flows. The coupled LeMANS-radiation code was demonstrated for Stardust and IRV2 configurations, while the coupled LeMANS-MOPAR code was validated for the Passive Nosetip Technology (PANT) experiment [1], successfully establishing feasibility. In Phase II, the primary focus is to advance the flow and ablation modeling capabilities of the LeMANS/MOPAR codes by including innovative models for: (1) Non-equilibrium surface thermochemistry; (2) Non-equilibrium pyrolysis chemistry; and (3) Non-gray, non-equilibrium radiation. All models will be implemented in a modular manner with particular attention paid to their coupling interfaces to facilitate easy coupling to a computational aerothermodynamics code of interest to NASA such as DPLR. The tool will be validated and applied to ablation-cooled re-entry flow problems relevant to NASA such as the Stardust capsule.

Primary U.S. Work Locations and Key Partners



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Small Business Innovation Research/Small Business Tech Transfer

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Organizations Performing Work	Role	Type	Location
CFD Research Corporation	Lead Organization	Industry	Huntsville, Alabama
Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations	
Alabama	California

Project Transitions

June 2011: Project Start

May 2013: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/138769)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

CFD Research Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

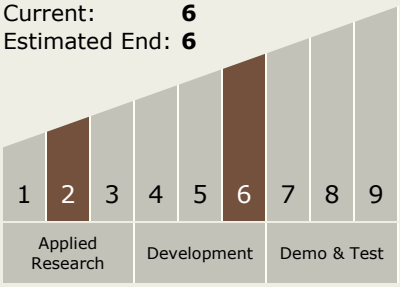
Carlos Torrez

Principal Investigator:

Ranjan Mehta

Technology Maturity (TRL)

Start: **2**
Current: **6**
Estimated End: **6**



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Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
  - TX09.4 Vehicle Systems
    - TX09.4.5 Modeling and Simulation for EDL

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System